An Industry / DOE Program to "Develop and Benchmark Advanced Diamond Product Drill Bits and HP/HT Drilling Fluids to Significantly Improve Rates of Penetration"

Optimization of Deep Drilling Performance

Team: William Gwilliam (Department of Energy/NETL);
Arnis Judzis, Alan Black (TerraTek);
Allen Sinor, Redd Smith (Hughes Christensen);
Ron Bland (Baker Hughes INTEQ Drilling Fluids);
Bud Trammel, Mark Reese (National Oilwell);
Tim Travis (ExxonMobil); Gary Collins (ConocoPhillips)
Jim Mullen (Marathon); Richard Harting (Aramco);
Rich Reiley (BP America); Stefan Miska (University of Tulsa)

Meeting at NETL Morgantown, December 17. 2002

An Industry / DOE Program to "Develop and Benchmark Advanced Diamond Product Drill Bits and HP/HT Drilling Fluids to Significantly Improve Rates of Penetration"

This program aims to benchmark drilling rates of penetration in selected simulated deep formations and to significantly improve ROP through a team development of aggressive diamond product drill bit - drilling fluid system technologies.

Context

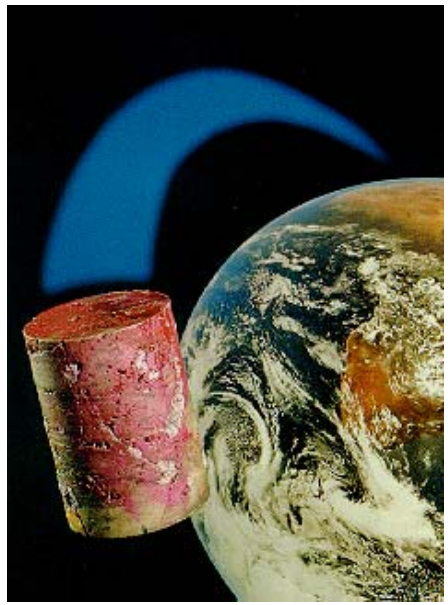
Team Roles & Project Management

Technical Objectives

Scope of Work

Budget Overview & Schedule

Looking Forward

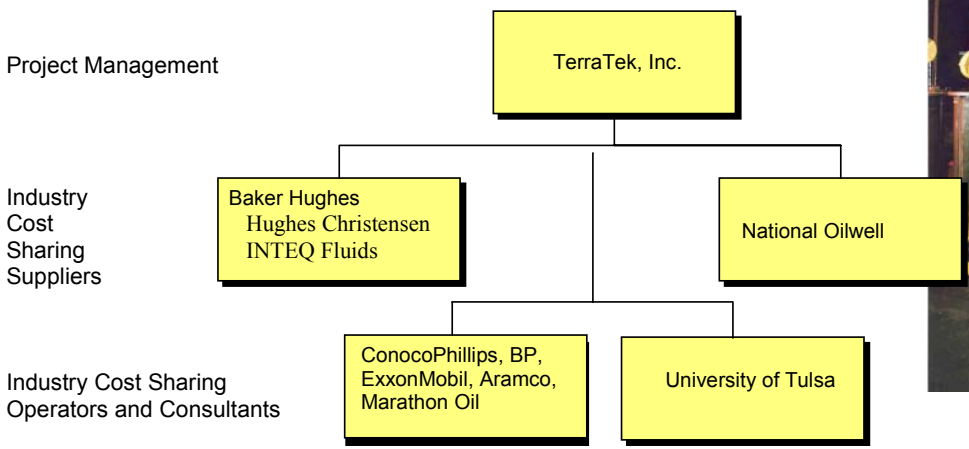


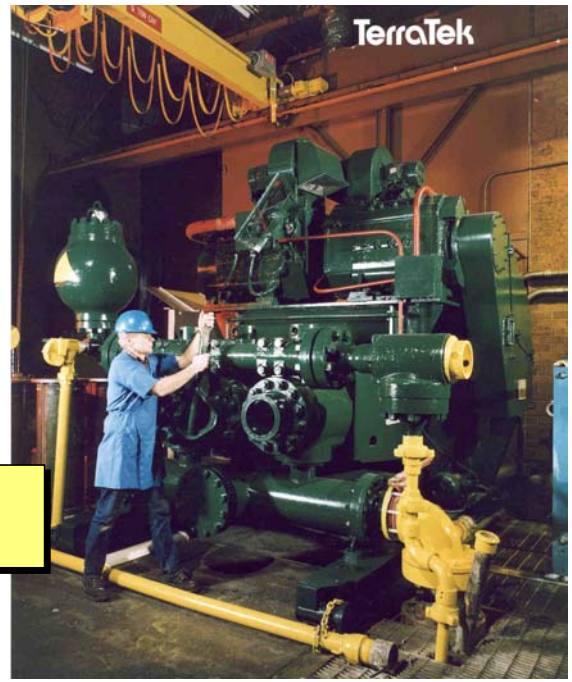
Context

- **Economic Benefit**
  - Domestic developments in drilling tools, fluids, and testing
  - Great potential for increased activities in deep gas plays
- **Drilling Performance**
  - Diamond product bit applications for increased rate of penetration
  - Directional drilling applications
  - Higher temperature drilling fluids
- **Target Markets**
  - Gas, deep gas plays
  - Mid continent, Overthrust, Appalachian Basin, etc.
- **Advantages in large-scale experiments in wellbore simulator –**
  - Economics (start-up with high day rates difficult with prototype tools)
  - Ability to compare tools and performance directly
  - Test rig 'height' offers easy access to tools/handling
  - Drilling conditions are carefully controlled & measured (data acquisition)
  - Equipment can be modified and retested
  - Provides wide range of experiments simulating deep field conditions - flow rates, pressure, rock types, rotary speed, fluid etc.

Team Roles and Project Management

Project Organization





Technical Objectives

- **Characterization of applications –**

  Determine deep drilling performance issues related to bits and fluids in operators' areas of challenge and commence with suppliers engineering evaluations of promising concepts.

- **Benchmark performance of 'best-in-class' products –**

  Conduct full-scale drilling tests in TerraTek's Wellbore Simulator at high pressures in hard rock to reveal deficiencies and design features important for improved deep drilling performance.

- **Develop aggressive diamond product bits and fluids to improve ROP –**

  Test and improve significantly drilling performance via emerging and newly developed drill bits and fluid systems.

- **Commercialization and field deployment –**

  Test and deploy via field testing on operator wells prototype bits and fluids developed as a result of the prior year effort.

Scope of Work

- **Phase 1 Feasibility Concept Definition –**

  Assess deep drilling applications requiring tool/fluid development
  Design, engineer, and plan HP drilling program
  Perform full-scale drilling tests
  Benchmark bit/fluid system performance
  Transfer technology

- **Phase 2 Prototype Development and Testing –**

  Design and construct prototype bits and fluid systems
  Test novel bit/fluid technologies at high pressures
  Transfer technology and review progress against plan

- **Phase 3 Demonstration and Commercialization –**

  Obtain Industry Advisors input for field trials
  Optimize drilling conditions through large-scale testing
  Perform field tests on developed systems
  Finalize 'lessons learned' in this program
  Finalize commercialization effort
  Prepare final report on 'Deep Drilling Optimization'

Budget Overview

Total Program $2,929 k; DOE share $1,692 k, Cost sharing $1,237 (42%)

	DOE, $k	Cost Share, $k
• Feasibility Concept Definition	704	259
• Prototype Development and Testing	571	368
• Demonstration and Commercialization	417	610
TOTALS	1,691	1,237

Looking Forward

- **TerraTek plans to convene team in Houston (probably end January 2003) to finalize test conditions and review bit and fluid developments**

  TerraTek
  Baker-Hughes (Hughes Christensen & INTEQ)
  National Oilwell
  University of Tulsa
  Operators (BP, Marathon, ConocoPhillips, ExxonMobil, Aramco)

- **Upgrades to pumping and pressure capability will be necessary beginning 2003.**

- **Outstanding issues - pumping capacity vs. pressure - bit size determination. TerraTek recommends that input from the Houston planning and engineering meeting help decide this.**

- **BP was particularly keen to conduct possible field trials of bits and fluids in 2005.**

Example Industry Support

bp

BP Amoco Corporation
Upstream Technology Group
P.O. Box 3092
Houston, TX 77253-3092

May 24, 2002

400 Wakara Way
Salt Lake City, Utah 84108

Dear Mr. Judzis:

BP America fully supports the objectives of your program to optimize deep drilling performance through development and benchmark testing of advanced drill bits and HP/HT fluids to significantly improve rates of penetration. BP America supports this program because of the potential benefits to reducing drilling costs in our deep gas drilling operations. To help facilitate this program, BP America hereby commits to providing in-kind services totaling $30,000. These in kind services may include labor and travel costs associated with the testing program as well as providing technical /engineering time to advise the project team. Additionally BP America is prepared to support additional testing in our field operations contingent on the results of the laboratory-testing program.

Sincerely,

Brian E. Miller
Bit & ROP Optimization Specialist
BP Upstream Technology Group

BAKER HUGHES

Hughes Christensen
RESEARCH & DEVELOPMENT

May 23, 2002

Mr. Arnis Judzis
Executive Vice President
TerraTek
University Research park
400 Wakara Way
Salt Lake City, UT 84104
(801) 584-2483

re: Deep Trek Program Solicitation No. DE-PS26-02NT41434-1
"Optimization of Deep Drilling Performance; Development and Benchmark Testing of Advanced Diamond Product Drill Bits and HP/HT Fluids to Significantly Improve Rates of Penetration"

Dear Mr. Judzis:

Hughes Christensen, Inc. (HCC), a division of Baker Hughes, Inc. designs, manufactures and markets rolling and fixed cutter drill bits for the petroleum industry. We have read your public abstract for the Deep Trek project submitted to the Department of Energy and we would like to express our interest in joining this joint industry project. We at HCC believe that this research has the potential to make a positive impact on the performance of drilling products to reduce exploration and development costs for these applications.

We would like to express our interest and support of funding for your proposal by providing the following in-kind materials and professional support. We will endeavor in good faith to support this three-year joint industry project by providing products and services with an estimated value of $317,000, the details of which are estimated below.

Description	Amount
Travel – phases I - III	$9,000
Drill Bits- budget for 8 units in phases I & II	
Rolling Cutter (4 ea. at $12k avg.)	$48,000
Fixed Cutter (4 ea. at $50k avg.)	$200,000
Engineering Support ($1000 per man day)	
Rolling cutter designs (30 days)	$30,000
Fixed cutter designs (30 days)	$30,000

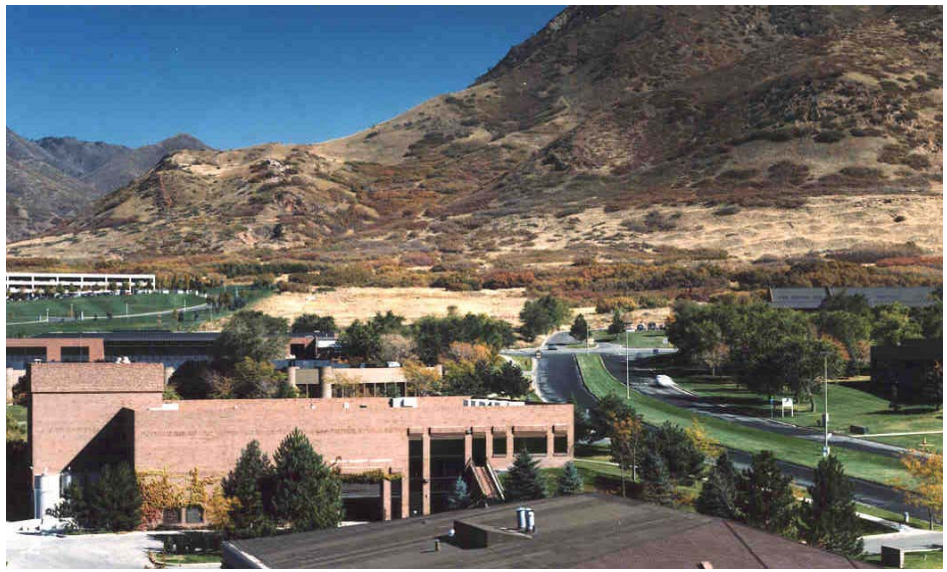
Sincerely,

Allen Sinor
Manager- Drilling Research

Redd Smith
Manager- Materials Research

9110 Grogans Mill Road The Woodlands, TX 77380 (713)363-6000 FAX (713)363-6099

- *Closure*
- *Questions & Answers*



TerraTek
400 Wakara Way
Salt Lake City, UT 84108
Alan Black (801) 584-2441, FAX x2406, ablack@terratek.com
Arnis Judzis (801) 584-2483, judzis@terratek.com

Accomplishments to date (contract started October 1, 2002

- **A Kick-off meeting was conducted at NETL's Morgantown facility on December 16, 2002. Baker Hughes and BP provided industry perspectives.**

- **The project has advanced the concept of combined input from both a bit and drilling fluid supplier to consider DeepTrek developments as a system - 'smart fluid / bits' for enhanced performance. Baker Hughes Inteq's Ron Bland met with TerraTek staff in Salt Lake City.**

- **Industry cost sharing accelerated with ARAMCO's interest in aggressive bits and willingness to join the team with funds. Originally proposed as DEA 148, ARAMCO's interests now parallel the DOE 'team' objectives.**

- **National Oilwell is currently studying options for pumping at high pressures, awaiting further refinement of test 'matrix'. They have already built some prototype high pressure pumping systems for deep applications and are evaluating progress in various projects on the merits of their systems.**

- **A February 13 technical meeting has been scheduled at Hughes Christensen in Houston to deliberate bit size and hydraulics best suited for first year's benchmarking and development of prototype equipment. This step will be crucial to focus engineering and design expenditures by Baker Hughes thus will form the basis of minimum expected performance as the program progresses. Commercial availability of the bits and fluids (and accelerated development by domestic competitors) will have the greatest immediate impact on the oil and gas industry.**